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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

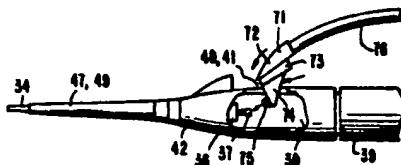
(51) International Patent Classification <sup>4</sup> :  A61B 17/00	A1	(11) International Publication Number: <b>WO 87/ 06116</b>  (43) International Publication Date: 22 October 1987 (22.10.87)
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(21) International Application Number: PCT/US87/00795 (22) International Filing Date: 8 April 1987 (08.04.87)  (31) Priority Application Number: 849,830 (32) Priority Date: 9 April 1986 (09.04.86) (33) Priority Country: US	(74) Agents: BOLAND, Thomas, R. et al.; Vorys, Sater, Seymour and Pease, 1828 L Street, N.W., Suite 1111, Washington, DC 20036-5104 (US).  (81) Designated States: BE (European patent), CH (European patent), DE (European patent), FR (European patent), GB (European patent), IT (European patent), JP, NL (European patent), SE (European patent).
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## Published

With international search report.

(54) Title: IRRIGATION/ASPIRATION MANIFOLD AND FITTINGS FOR ULTRASONIC SURGICAL ASPIRATION SYSTEM



(57) Abstract

An ultrasonic surgical aspirator having an improved irrigation/aspiration manifold and components to facilitate quick connections of the irrigation and aspiration lines to a handpiece. In combination with a handle assembly (31) having an ultrasonic vibrator (32) for vibrating an ultrasonic tip (34) and a nosecone (33), a nosecone extension (42) defining a rotating joint (43) for connection to the nosecone in an articulating joint for connection to a rigid or flexible flue (47, 49). The nosecone extension further defines an irrigation cowl (77) having an irrigation port for receiving an irrigation connector (77) for connecting the irrigation fluid to the nosecone extension for passage of irrigation fluid through the nosecone extension and a flue about the surgical tip. An aspiration tubulation connector (71) adapted to securely fit a slot through the nosecone and nosecone extension connects an aspiration port (37) on the tip to the aspiration tube (76) for connection to a pump into a discard.

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- 1 -

1                   IRRIGATION/ASPIRATION MANIFOLD AND  
2                   FITTINGS FOR ULTRASONIC SURGICAL ASPIRATION SYSTEM

3  
4                   Background of the Invention

5                   This invention relates to an ultrasonic sur-  
6                   gical aspiration system. More particularly, this  
7                   invention relates to an improved irrigation/aspiration  
8                   manifold and associated parts for such an ultrasonic  
9                   surgical aspiration system. Still more particularly,  
10                  this invention relates to the use of mating connections  
11                  in such a system to allow easy, rapid, and foolproof  
12                  connections to the irrigation, aspiration, and tissue  
13                  relief ports in an ultrasonic surgical aspiration  
14                  system. In addition, this invention relates to an  
15                  improved transition member which allows an easy  
16                  exchange of flues, articulation without leakage, and a  
17                  swivel joint which permits use of curved ultrasonic  
18                  members in an ultrasonic surgical aspiration system.

19                  Ultrasonic surgical devices are known for  
20                  performing a number of surgical procedures. A repre-  
21                  sentative device is shown in United States Patent No.  
22                  3,589,363 describing a hand-held instrument having an  
23                  operative tip vibrating at a frequency in the ultra-  
24                  sonic range, and in which a handpiece includes a trans-  
25                  ducer. Connections are provided on the handpiece to a  
26                  source of treatment fluid and to a pump to withdraw  
27                  suspended tissue particles in a fluid from an operative  
28                  site.

29                  The design of such ultrasonic surgical  
30                  devices has depended not only on the technical and  
31                  functional requirements of a resonant body, but also  
32                  upon their surgical application. Thus, the parameters  
33                  of the system, the length of the tip, and the tip  
34                  stroke and diameter to be acceptable for a useful sur-  
35                  gical device in various operative site areas have  
36                  developed over the years, based upon experience with

- 2 -

1 such devices. Attention has been paid in the art to  
2 the development of the various components in the  
3 system, with the result that an ultrasonic surgical  
4 aspiration instrument is well-known and used as a  
5 sophisticated high-technology surgical instrument.

6 Such a system has been developed and produced  
7 by the assignee of this invention which comprises an  
8 assembly of an acoustic vibrator, a nosecone, a flue, a  
9 handpiece and a manifold. The assembled system pro-  
10 vides a source of irrigation fluid to an operative site  
11 and the aspiration of surgically-excised particles from  
12 the site under the control of precise and sophisticated  
13 instrumentation. A number of modifications to such a  
14 basic system have been made with respect to such items  
15 as the length and shape of the tip, its coupling with a  
16 transducer, the use of an extender (whether curved or  
17 straight), and others. Usually, the components for a  
18 surgical use are provided as a part of a sterile sur-  
19 gical kit to be used and discarded after each surgical  
20 procedure.

21 The acoustic vibrator assembly includes the  
22 combination of a transducer connected to a handpiece  
23 for providing a source of ultrasonic vibrations to a  
24 tip. When the tip is connected to the transducer, or  
25 to a straight or curved extender interposed between the  
26 tip and the transducer, provisions are made in the kit  
27 for connecting the components to a predetermined level  
28 of tightness. A nosecone assembly is then assembled  
29 from a nosecone which is provided with O-ring seals in  
30 grooves in the nosecone and slid over the acoustic  
31 vibrator until seated. A flue is slid over the tip and  
32 hand tightened to the nosecone to provide a passage  
33 within the flue and about the length of the tip for  
34 irrigation fluid from the nosecone to the tip. A nose-  
35 cone adapter may be used with an extender flue to pro-  
36 vide alternative length and shapes for the convenience

- 3 -

1 of the surgeon and safety for the patient for parti-  
2 cular operations. When used, the nosecone adapter is  
3 tightened to the nosecone and the extender flue is  
4 gently pushed over the tip of the nosecone so that the  
5 curve of the extender and flue match without the flue  
6 touching the tip. The body of the flue adapter is  
7 twisted to centralize the tip within the flue. There-  
8 after, the acoustic vibrator and the nosecone with the  
9 flue attached are inserted into a handpiece housing and  
10 seated so that the fluid manifold assembly may be com-  
11 pleted.

12 An irrigation tube with a flexible applicator  
13 cable is fed through a slot in the nosecone and through  
14 an aspiration port on the exterior of the tip. By  
15 gently pulling the cable through the port in the tip,  
16 the aspiration tubing attaches to the aspiration port  
17 on the tip. The other end of the aspiration tubing is  
18 connected about a pump to control aspiration pressures  
19 and to a discard region for discarding extracted  
20 tissue. Metallic clips are provided to secure the  
21 aspiration tubing to the exterior of the handpiece  
22 housing. Thereafter, irrigation tubing is connected to  
23 the irrigation port on the nosecone for connection at  
24 its other end to a source of irrigation fluid, such as  
25 an IV bottle. Additional clips are provided to the  
26 handpiece cable to secure the manifold.

27 Thus, the assembled system is able to provide  
28 irrigation fluid from an irrigation fluid source  
29 through tubing to an irrigation port and through the  
30 nosecone into the area intermediate the tip and the  
31 flue to irrigate the surgical site adjacent the tip  
32 extending from the flue. Aspiration occurs from the  
33 operative site through an aspiration passage to the  
34 aspiration port and through the aspiration tubing to  
35 aspirate surgically-excised particles.

- 4 -

1           As can be seen from the above simplified  
2 description, several fluid connections must be made at  
3 the surgical handpiece and elsewhere to provide irriga-  
4 tion to and aspiration from the surgical site. While  
5 such prior designs were satisfactory, they utilized  
6 plain tubing ends which require skilled and special  
7 application techniques for making the connections. In  
8 addition, the assembly procedure was further compli-  
9 cated by the number of tips and extended options avail-  
10 able to the surgeon. It thus remained a problem in the  
11 art to assure easy, rapid and fool-proof connection of  
12 the irrigation, aspiration and tissue release ports to  
13 the correct tubing and location, since such connections  
14 are made in an operating room in preparation for sur-  
15 gery or during the surgical procedure itself in certain  
16 situations where modification or reconnection is  
17 needed.

18           Thus, it is a main objective of this inven-  
19 tion to provide a mating component system for an ultra-  
20 sonic surgical vibrator which uses quick-connecting  
21 devices to facilitate connection of the components and  
22 tubing to the irrigation, aspiration and tissue release  
23 ports.

24           It is another object of this invention to  
25 provide an improved transition piece to permit an easy  
26 exchange of flues between a rigid flue and a ribbed  
27 flexible flue for easy connection to an assembly of a  
28 handle, nosecone, and tip.

29           It is an additional object of this invention  
30 to provide a nosecone extension which provides a rota-  
31 ting joint for assembly to a nosecone and an articula-  
32 ting joint for connection to either a rigid flue  
33 secured with or without an O-ring or to a ribbed flex-  
34 ible flue.

35           It is a further object of this invention to  
36 provide a ribbed flexible flue structure for convenient

- 5 -

1 use with an ultrasonic surgical aspiration system of  
2 the type described.

3 It is a further object of this invention to  
4 provide a nosecone extension adapter for ready connec-  
5 tion to an extender connected to an assembly of a  
6 handle, nosecone, and vibrator for receiving therein an  
7 extended tip and an extender sheath which is connected  
8 to the nosecone extension adapter for connection  
9 between the extender sheath and a flue adapter having  
10 an articulating joint for receiving either a ribbed  
11 flexible flue or a rigid flue as described.

12 It is an additional object of this invention  
13 to provide an aspiration tubulation connector for  
14 secure connection to an aspiration tube and quick,  
15 secure connection with limited motion to the aspiration  
16 port on the tip within a confined space in the interior  
17 of the handpiece.

18 It is a further object of this invention to  
19 provide a quick connect fitting for connection between  
20 an end of the irrigation tube and the irrigation tube  
21 fitting by turning and locking, and easy connection to  
22 an irrigation port on a transition member or nosecone  
23 extender.

24 It is a more general object of this invention  
25 to provide an ultrasonic surgical aspiration system  
26 with conveniently-usable components capable of easy  
27 assembly in diverse combinations while minimizing error  
28 in the assembly, which components are adapted for easy  
29 fluid connection.

30 These and other objects of the invention will  
31 become apparent from the written description of the  
32 invention which follows.

33 Brief Summary of the Invention

34 Directed to achieving the foregoing objects  
35 and to overcoming problems in the art, in one aspect,  
36 the invention relates to a nosecone extension member

- 6 -

1 defining at its inlet end a rotating joint for secure  
2 connection to a nosecone in an ultrasonic surgical  
3 system, and an articulating joint at its outlet end for  
4 connection to either an articulated rigid flue having  
5 an O-ring seal to prevent leakage, or to a ribbed flex-  
6 ible flue for use with curved tip members. The rigid  
7 flue is preferably optically transparent, having a  
8 tapered body defined in cross-section by an annular  
9 wall terminating at its connecting end in an arcuate  
10 seal portion to receive therein an O-ring for connec-  
11 tion to the articulating joint on the nosecone exten-  
12 sion or on a flue adapter connected to an extender  
13 sheath connected to a nosecone extension adapter. Such  
14 a construction permits the rigid flue to be articulated  
15 relative to the articulated joint to center the tip  
16 intermediate therein in a rigid yet leak-proof  
17 manner. The flexible flue includes a plurality of  
18 spaced interior ribs in a similar construction extend-  
19 ing in the interior of the body thereof. The connect-  
20 ing end of the flexible flue defines a diameter greater  
21 than the diameter of the flexible flue near its  
22 connecting end and angularly merging with the flue  
23 body.

24 The nosecone extension defines an articula-  
25 ting joint at one end thereof as having a recess for  
26 receiving an O-ring seal at said joint. The nosecone  
27 extension is defined by a body defining a passage  
28 therein through which passage the ultrasonically-  
29 vibrated tip passes. The passage includes an inwardly  
30 turned radius at one end thereof for securing the nose-  
31 cone extension to the nosecone with a snapping action,  
32 while permitting rotation of the nosecone extension  
33 about the nosecone. The nosecone extension further  
34 defines an irrigation fluid passage merging with the  
35 tip passage in the nosecone toward its forward end and  
36 emerging as an irrigation cowl from the body of the

- 7 -

1       nosecone extension near its inlet end for receiving  
2       therein an irrigation fitting for easy connection to  
3       irrigation tubing. Such a nosecone extension structure  
4       facilitates ready and easy connection of a flue  
5       (whether flexible or rigid) with an O-ring seal at the  
6       forward end thereof for articulation relative to the  
7       protruding tip through the nosecone extension, easy  
8       rotatable mating connection with a mating structure on  
9       the nosecone, and an irrigation connecting port for  
10      ready connection of the irrigation tubing with an irri-  
11      gation fitting. Preferably, the nosecone extension or  
12      transition piece snaps onto the nosecone while allowing  
13      rotation of the irrigation port relative to the  
14      resonator of the handpiece for convenience of instal-  
15      lation.

16           The irrigation fitting according to the  
17       invention comprises a tapered length of tubing defining  
18       a first portion angularly bent relative to the remain-  
19       ing portion, a central radially-extending rib for  
20       limiting insertion of the tapered end into the irriga-  
21       tion port on the nosecone extension and a barbed  
22       exterior end over which irrigation tubing may be  
23       securely slip fit while resisting withdrawal  
24       therefrom. Such a fitting easily cooperates with the  
25       irrigation port on the nosecone irrigation cowl to  
26       facilitate connection and location of the irrigation  
27       tubing.

28           According to another aspect of the invention,  
29       for use in an assembly of a tip/nosecone/handle sub-  
30       assembly secured at its foward end to an extender for  
31       housing an extended tip, a nosecone extension adapter,  
32       which is shaped similarly to the nosecone extension  
33       previously described, is provided having a rotating  
34       joint for connection to the nosecone and a forwardly  
35       extending member having an outwardly turned forwardmost  
36       portion for securing thereon an extender sheath. In

- 8 -

1 this combination, a flue adapter defining at its for-  
2 ward end an articulating joint and at its aft end a  
3 tube and seal arrangement receives either the rigid  
4 flue or the ribbed flexible flue as previously  
5 described.

6 In another aspect of the invention, an aspir-  
7 ation tubulation connector is provided for quickly  
8 connecting the aspiration tubing securely at one end  
9 thereof to an inward port and is connected at its out-  
10 ward port to the aspiration port on the cutting tip  
11 through a rotating movement through a slot in the nose-  
12 cone subassembly. The axis of connection of the aspir-  
13 ation tubing after the tubulation connector is secured  
14 lies parallel to the axis of connection of the outward  
15 port so that the tubulation connector defines a portion  
16 lying on the surface at the exterior of the nosecone  
17 and a portion fitted into the slot in the nosecone.  
18 This fitting in addition provides a non collapsable key  
19 for aspiration connection.

20 In still another aspect of the invention, the  
21 aspiration tubing is connected to a T-valve assembly at  
22 a location intermediate the handpiece and a pinch valve  
23 and vacuum cannister for connection with a duckbill  
24 valve vent fitting.

25 These and other features of the components of  
26 the assembly and of the assembly itself will become  
27 further apparent from the detailed written description  
28 of the invention which follow, taken in conjunction  
29 with the drawings.

30 Brief Description of the Drawings

31 In the drawings:

32 Fig. 1 is a diagrammatic assembly drawing of  
33 the handpiece components of a known ultrasonic surgical  
34 aspiration system;

35 Fig. 2 is an assembly diagram similar to Fig.  
36 1 modified according to the invention to include a

- 9 -

1       nosecone extension with an irrigation cowl adapted for  
2       an articulating connection with either a rigid flue or  
3       a ribbed flexible flue and a rotating connection to the  
4       nosecone;

5           Fig. 3 is a diagrammatic assembly drawing of  
6       the components of a modified ultrasonic system using an  
7       extender with an extender sheath and extender tip, and  
8       illustrating a nosecone extension adapter and flue  
9       adapter according to the invention, the former defining  
10      an irrigation cowl and a rotating connector with the  
11      nosecone, the latter articulately connecting either a  
12      ribbed flexible flue or a rigid flue;

13       Figs. 4A and 4B together show the use of an  
14       aspirator tubulation connector according to the inven-  
15       tion for quickly connecting aspiration tubing to an  
16       aspiration port within the nosecone through minimum  
17       rotation;

18       Fig. 5 illustrates the assembled handpiece  
19       having the components shown in Fig. 2 and illustrating  
20       the improved connectors for the aspiration tube, the  
21       irrigation tube, and to the tissue release port on a  
22       panel of a control instrument;

23       Fig. 6 is a side cross-sectional view of a  
24       nosecone used in the assemblies of Figs. 1-5 to which  
25       either a nosecone extension or nosecone extension adap-  
26       ter according to the invention is connected;

27       Fig. 7 is a side cross-sectional view of an  
28       articulated rigid flue to provide an articulating con-  
29       nection to the articulating joint on the nosecone  
30       extension or the flue adapter according to the  
31       invention;

32       Fig. 8 is a side cross-sectional view of a  
33       ribbed flexible connector according to the invention  
34       for connection to either the nosecone extension or the  
35       flue adapter according to the invention for providing  
36       an articulating mounting suitable for curved tip  
37       members;

- 10 -

1                   Fig. 9 is a side cross-sectional view taken  
2        along line 9-9 of Fig. 8 near the exit port of the  
3        flexible flue;

4                   Fig. 10 is a side cross-sectional view taken  
5        along line 10-10 of Fig. 8 near the entry port of the  
6        flexible flue;

7                   Fig. 11 is a side plan view of a nosecone  
8        extension used in the embodiment of Fig. 2 to connect  
9        either flue embodiment to the nosecone;

10                  Fig. 12 is a cross-sectional view taken along  
11       line 12-12 of Fig. 11 and rotated through ninety  
12       degrees to illustrate the irrigation cowl and tubing  
13       port for receiving the irrigation tubulation connector;

14                  Fig. 13 is a cross-sectional view of Detail  
15       13 taken as shown in Fig. 12.

16                  Fig. 14 is an end view taken from the exit  
17       end of Fig. 12 showing the articulating joint of the  
18       nosecone extension according to the invention.

19                  Fig. 15 is an end view taken from the end of  
20       the nosecone extension opposite to that shown in Fig.  
21       14 and further illustrating entry of the irrigation  
22       port into the tip passage defined by the nosecone  
23       extension according to the invention;

24                  Fig. 16 is a side cross-sectional view of a  
25       nosecone extension adapter having a rotating connecting  
26       end for use in the embodiment of Fig. 3 for connecting  
27       an extender sheath at its outboard port and connection  
28       to the nosecone at its inboard port in the embodiment  
29       of Fig. 3 using a tip and curved extender with an  
30       extender sheath;

31                  Fig. 17 is a cross-sectional view of Detail  
32       17 at the outboard port of the nosecone extension  
33       adapter according to the invention;

34                  Fig. 18 is a side cross-sectional view of a  
35       flue adapter for use in the embodiment of Fig. 3 for  
36       connection at its inboard port to the extender sheath

- 11 -

1 and having an articulating joint at its outboard port  
2 for connection to either flue embodiment;

3 Fig. 19 is a cross-sectional view of Detail  
4 19 shown in Fig. 18;

5 Fig. 20 is a plan view of the flue adapter  
6 according to the invention from which the cross-section  
7 of Fig. 18 is taken;

8 Fig. 21 is an end view of the flue adapter  
9 shown in Figs. 18-20 showing its internal centering  
10 rib;

11 Fig. 22 is a side cross-sectional view of the  
12 construction of the irrigation fitting shown in Fig. 5  
13 for insertion into the nosecone extension of Figs. 11-  
14 15 on the nosecone extension adapter of Fig. 16;

15 Fig. 23 is a side plan view of the irrigation  
16 fitting showing its contour and bend after turning when  
17 in place;

18 Fig. 24 illustrates a plan view of the aspira-  
19 tion tubulation connector according to the invention;

20 Fig. 25, comprising Figs. 25A, 25B, 25C, 25D  
21 and 25F together, illustrates the left side portion of  
22 the aspirator tubulation connector respectively showing  
23 a plan view, a left end view, a right end view, a top  
24 view, and a bottom view of the left side of the  
25 aspirator tubulation connector;

26 Fig. 26 is a view taken along detail 26 of  
27 Fig. 25 showing seal detail;

28 Fig. 27, comprising Figs. 27A, 27B, 27C, 27D,  
29 and 27E together, respectively illustrates the right  
30 side of the aspirator tubular connector and respec-  
31 tively shows a plan view, a left side view, a right  
32 side view, a top view, and a bottom view; and

33 Fig. 28 is a cross-sectional view of the seal  
34 used for connection to the vacuum port on the panel of  
35 an instrument for controlling one of the system param-  
36 eters.

- 12 -

1                   Detailed Description of the Preferred Embodiment

2                   Fig. 1 illustrates components of a handpiece  
3                   of a known ultrasonic surgical aspirator system desig-  
4                   nated generally by the reference numeral 30. The  
5                   system 30 includes a handle assembly 31 connected to an  
6                   ultrasonic transducer and vibrator 32, a nosecone 33  
7                   and an ultrasonically-vibrated surgical tip 34. The  
8                   combination of the vibrator 32 and the tip 34 comprises  
9                   an accoustic vibrator assembly for vibrating the tip  
10                  for surgical excision at a frequency in the ultrasonic  
11                  range. The tip 34 defines an accoustic coupling  
12                  surface 35 forward of a threaded connection 36 and  
13                  terminates at its aft end in an aspiration port 37, in  
14                  a manner known to the art. The vibrator 32 defines an  
15                  internally threaded female threaded portion 38 for  
16                  mating with the threaded portion 36 of the tip 34.  
17                  When so threadedly engaged, the aspiration port 37 is  
18                  located within a chamber 39 defined in the vibrator 32  
19                  which is accessed through a slot 40. The nosecone 33  
20                  also defines a slot 41 which when threaded to the  
21                  handle assembly lies in axial alignment and in register  
22                  with the slot 40. The nosecone 33 is threaded onto an  
23                  external threads 45 on a threaded portion of the handle  
24                  assembly 31. Such assemblies are known to the art for  
25                  their intended purpose.

26                  The procedure for connecting the irrigation  
27                  and aspiration tubing lines to the assembly 30 in Fig.  
28                  1 has been described generally in the background of the  
29                  invention. It should be understood that when the  
30                  components are fully assembled, the tip 34 defines an  
31                  annular space at the outlet of the vibrator 32 through  
32                  the nosecone 33 for conducting irrigation fluid from a  
33                  fluid source to the surgical site at the distal portion  
34                  of the tip 34. In addition, aspiration tubing is con-  
35                  nected to the aspiration port 37 through the aligned  
36                  slots 41 and 40 as previously described. It should be

1 further understood that power is supplied to the unit  
2 from a console which otherwise controls the parameters  
3 of the surgery, including vacuum at a suction port at  
4 the face of the unit for controlling the aspiration  
5 rate through the aspiration tubing. The irrigation  
6 tubing is connected to a source of irrigation fluid  
7 located at a predetermined height relative to the sur-  
8 gical site and the manner of use of such instrument in  
9 a number of surgical procedures using a console of the  
10 type generally described is well-known in the art.  
11 Accordingly, the aspects of this invention which relate  
12 to its mechanical connections among the various compo-  
13 nent parts and of the several pieces of tubing forming  
14 the completed unit can be abbreviated.

15 Figure 2 illustrates the assembly 30 of Fig.  
16 1 in its assembled state. A nosecone 33 is shown in  
17 greater detail in Fig. 6 to provide a basis for under-  
18 standing the connection of a nosecone extension 42  
19 according to the invention. Throughout this specifi-  
20 cation the inward, inboard, or inlet side of a  
21 component refers to the portion of the component nearer  
22 to the handpiece assembly 30, whereas the outward,  
23 outboard, or outlet side of the component refers to the  
24 side nearer the surgical site and operative tip 34.

25 Thus in summary, the nosecone extension 42  
26 provides at its inward side a rotating joint 43 which  
27 permits the nosecone extension 42 to be snapped on to  
28 the nosecone 33 as will be described in greater  
29 detail. The extension 42 also defines an outward  
30 articulating joint 44 for receiving either a rigid flue  
31 47, shown in Fig. 7, or a flexible flue 49, shown and  
32 described in connection with Figs. 8-10. The articu-  
33 lating joint 44 permits easy insertion of either flue  
34 embodiment in an articulated fashion to permit adjust-  
35 ment of the tip centrally of the bore of either flue,  
36 and with a leakproof arrangement. Accordingly, the

- 14 -

1 articulating joint 44 may be connected to the inward  
2 end 46 of the rigid flue 47 or the inward end 48 of the  
3 ribbed flexible flue 49. When the rigid flue 47 is  
4 used, an O-ring 50 is mounted in an O-ring recess 51 in  
5 the articulating joint 44 to provide a seal to prevent  
6 leakage at that connection.

7 The development of convenient alternative  
8 components has produced the representative alternative  
9 embodiment shown in the assembly designated generally  
10 by the reference numeral 55 in Fig. 3. That assembly  
11 uses an extended tip 54a which is curved as is an  
12 extender 56 which together are connected to the hand-  
13 piece assembly 30 generally in the manner described. A  
14 nosecone extension adapter 57 is shown in greater  
15 detail in Figs. 16 and 17 to define at its inward end a  
16 rotating joint 58 to be secured to a snap ring assembly  
17 59a on the outboard or outward end of the nosecone 33  
18 in the handpiece assembly 30. The outward end 59 of  
19 the nosecone extension adapter 57 is structurally sized  
20 and adapted to receive an inward end 62 of a curved  
21 extender sheath 60 in a slip fit arrangement thereon.  
22 A flue adapter 61, shown in greater detail in Figs. 18-  
23 21, defines at its inward end 68 a cylindrical member  
24 67 having an outwardly flared portion 69 for securing  
25 the flue adapter 61 within the wall at the outward end  
26 66 of the extender sheath 60. The outward end 70 of  
27 the flue adapter 61 defines an articulating joint 70  
28 similar to the articulating joint 44 on the nosecone  
29 extension 42 in Fig. 2 for receiving a ribbed flexible  
30 flue 49 or a rigid flue 47 in the same manner as  
31 referred to above. The ribbed flexible flue 49 may be  
32 conveniently used instead of the rigid flue 47 for  
33 curved members such as the tip 54A and the extender 56.

34 An important feature of the invention, as  
35 best seen in Figs. 4A and 4B and in detail in Figs. 24-  
36 26, involves the use of an aspiration tubulation

- 15 -

1 connector 71 for connecting the aspiration tubing 76 to  
2 the aspiration port 37 on the tip 34 within the chamber  
3 39 on the interior of the assembly 30. With the orient-  
4 tation shown in Fig. 4A, the slots 40, 41 lie in the  
5 upper portion of the sketches to show the aspiration  
6 tubulation connector 71 which has an outer body portion  
7 72 rigidly secured to the aspiration tubing 76 and a  
8 transition portion 74 defining an outward port 75  
9 inserted in the slots 40, 41 ready for mating of the  
10 outward port 75 with the port 37 of the tip 34. Fig.  
11 4B shows the positioning of the aspirator tubulation  
12 connector 71 after the connection is manually made  
13 wherein the outer body portion 72 lies along the wall  
14 of the nosecone extension 42 and includes a seating  
15 portion 73 seated in the slots 40, 41. The body  
16 portion 72 is shaped to receive the fingers of the  
17 assembler in a convenient fashion, while the seating  
18 portion 73 is sized to provide a tactile indication  
19 that the outward port 75 has properly engaged the port  
20 37. The details of the aspiration tubulation connector  
21 will be described and seen later in connection with  
22 Figs. 24-27. Accordingly, the use of the aspiration  
23 tubulation connector 71 according to the invention  
24 provides a quick, convenient and fool-proof method for  
25 connecting the aspiration tube 76 to the aspiration  
26 port 37 and avoids the manipulative difficulty  
27 associated with the threading of a cable connected to  
28 the aspiration tubing through the aspiration port in  
29 the tip after insertion through the slot 41 as in the  
30 prior art embodiment. Thus, the connector 71 defines  
31 an aspiration passage through the wall of the handpiece  
32 assembly 31.

33 As shown in Figs. 4A and 5, after connecting  
34 the connector 71 as described, the aspiration tube 76  
35 lies along the body of the handle assembly 31 and is  
36 secured thereon by resilient bands 76A similar to the

- 16 -

1 current manner. Because of the rigid or elastomeric  
2 structural connection, a fluid tight connection is  
3 assured in spite of manipulations of the handpiece  
4 during the surgical procedure.

5 As also shown in general in Fig. 5, the nose-  
6 cone extension 42 includes an outwardly extending irri-  
7 gation cowl or housing 77 for receiving an irrigation  
8 fitting 78, described in greater detail in connection  
9 with Figs. 22 and 23. An irrigation fitting 78 is  
10 inserted in the irrigation housing 77 on the nosecone  
11 extension or transition 42 which, upon a certain turn  
12 and lock arrangement, secures an irrigation tube 39 to  
13 the assembled handpiece 31. The other end of the irri-  
14 gation tube 39 is connected, as is known, to a hanging  
15 bottle of irrigation solution.

16 Fig. 5 shows a further feature of the  
17 assembly according to the invention involving the use  
18 of a seal 94 connected to the aspiration tube 76 having  
19 therein a duckbill valve connected to a tissue release  
20 port on the front panel of a control unit (not  
21 shown). Thus, a simple T-valve assembly with seal is  
22 defined while the other end of the aspiration tube 76  
23 is connected to a pinch valve on the control console  
24 for controlling aspiration, and to a vacuum canister  
25 (not shown) for receiving the discharged aspirated  
26 particles.

27 The assembly of components as described in  
28 connection with Figs. 1 through 5 makes simple the  
29 connections necessary at the surgical handpiece 31 and  
30 elsewhere to bring irrigation to and aspiration from  
31 the surgical site. Those components and their assembly  
32 avoid the use of plain tubing ends which required  
33 skilled special application techniques as described,  
34 for making the connections, while providing quick  
35 connect devices which allow easy, rapid and fool-proof  
36 connection of the irrigation, aspiration, and tissue

- 17 -

1 release ports during setup of the instrument for  
2 surgery. The improved transition piece, or nosecone  
3 extension 42 on the handpiece 31 further permits an  
4 easy exchange of flues between the rigid and flexible  
5 embodiments, as may be necessitated or desired during  
6 surgery and their articulation for the convenience of  
7 the surgeon and to assure smooth even flow of irriga-  
8 tion fluid together with a swivel joint which permits  
9 the use of curved ultrasonic tips, whether of normal  
10 length or extended.

11 In order to provide the basis for under-  
12 standing in greater detail the assembly according to  
13 Figs. 2-5, a cross-section of the nosecone 33 is shown  
14 in Fig. 6. The nosecone 33 defines a generally cylin-  
15 drical wall-portion 101 having a circular cross-section  
16 defining a plurality of stepped chambers 102 on the  
17 inward side thereof and terminating in a snap-ring  
18 recess 103 which merges into a tapered forward portion  
19 104 at the forward end thereof. The slot 41 in the  
20 nosecone 33 is defined in the wall 101 in the forward-  
21 most portion of the nosecone 33. A chamber 105 is  
22 defined interiorly of the slot 41, while one of the  
23 stepped chambers 102 defines an interior thread for  
24 threaded engagement with mating threads 45 on the  
25 handle assembly 31. Preferably, a pair of opposed  
26 slots 41 are provided.

27 The tapered forward end 104 and the recess  
28 103 are sized and arranged to receive conveniently and  
29 securely the rotating joint 43 on the nosecone  
30 extension 42, as described in connection with Fig. 2.

31 At the outward end of the nosecone extension  
32 42, either of a pair of flue embodiments 47 and 49 are  
33 located to define the irrigation fluid passage. Thus,  
34 in Fig. 7, a rigid articulated flue 47 is shown in  
35 cross-section as defined by an elongated, tapered  
36 member 110, preferably made from plastic, and defining

- 18 -

1 an axially elongated bore 111 therein. At its outer-  
2 most end 112, the bore 111 defines a cross-sectional  
3 area sufficient to permit the distal end of the tip 34  
4 to pass therethrough, while defining an annulus between  
5 the tip end and the wall 112 for the passage of irriga-  
6 tion fluid therethrough to the surgical site. Prefer-  
7 ably, the taper of the interior wall is on the order of  
8 about 3 degrees while the taper of the exterior wall is  
9 on the order of about 4 degrees so that the wall  
10 gradually thickens towards its inward end 113. On the  
11 interior portions of the inward end 113 are defined a  
12 pair of arcuate recesses 114 forming portions of the  
13 diameter of a circle and sized to be securely but rota-  
14 tionally received on the articulating joint 44 of the  
15 nosecone extension 42. The center of the circle  
16 defining the surfaces 114 lies outwardly from the hand-  
17 piece and, within the body of the unit so that the  
18 minimum wall thickness lies inwardly from the end  
19 113. Such an overlapped construction permits a snap  
20 fit of the articulated flue onto the articulated joint  
21 to facilitate the insertion of the flue on the articu-  
22 lated joint 44 and changing flues as may be necessary  
23 or desirable during surgery.

24 A ribbed flexible flue 49 is shown in Fig. 8  
25 as including an axially elongated body portion 120  
26 generally defined in cross-section with a circular  
27 annulus and defining on the interior thereof a plural-  
28 ity of spaced ribs 121 on the interior surface of the  
29 body portion 120 along a predetermined length  
30 thereof. Fig. 9 illustrates an embodiment in which  
31 three such inwardly projecting ribs 121 are used, each  
32 located 120 degrees apart on the circumference of the  
33 bore. At its inward end, the flexible flue 49 is  
34 defined by a radially outwardly extending portion 123  
35 which merges into an angular portion 124 which further  
36 merges into the wall of the body 120. The ribs provide

- 19 -

1 structural rigidity to the flexible flue 49 while per-  
2mitting its flexure to accommodate curved tips and to  
3 permit easy centering of the flexible flue 49 about the  
4 tip 34 located therein, as in the alternative embodi-  
5 ment. A typical taper is on the order of 2 degrees and  
6 the angled portion 124 may be oriented relative to the  
7 radially outwardly extending portion 123 at an angle of  
8 about 45 degrees. In the alternative, only a single  
9 rib, which is preferably a spiral, may be used, or more  
10 than three ribs, such as six ribs located 60 degrees  
11 apart, may be used. Fig. 9 illustrates a cross-section  
12 of the flexible flue 49 taken near its outward end 126,  
13 while Fig. 10 shows a cross-section taken at about the  
14 location in the interior of the flexible flue 49 where  
15 the ribs 20 terminate so that the portion 127 is free  
16 from such interior ribs.

17 Figs. 11-15 together illustrate the nosecone  
18 extension 42 shown in the embodiment of Fig. 2. As  
19 described, the nosecone extension 42 is characterized  
20 as providing a rotating joint 43 at its inward or rear-  
21 ward end, and an articulating joint 44 at its outward  
22 or forward end. The nosecone extension 42 is defined  
23 by a body 140 which includes a generally cylindrical  
24 portion 141 and an integral tapered conical portion 142  
25 which tapers to its maximum diameter at its inboard end  
26 143. The nosecone extension is preferably made from a  
27 suitable medical grade plastic such as polycarbonate.  
28 The area in which the tapered portion 142 merges into  
29 the generally cylindrical portion 141 is defined by a  
30 gentle recess 143. Outwardly of the portion 141 is  
31 formed a generally circular cross-sectioned articula-  
32 ting joint having a recess 146 between circular  
33 areas. The outward surfaces of the arcuate portions  
34 144 and 145 of the articulating joint 44 lie on the  
35 diameter of a circle having its center on the axis of  
36 the nosecone extension 42. The diameter of the circle

1       is sized to receive the inward end of either the ribbed  
2       flexible flue 49 or the rigid flue 47 in a snap fit,  
3       quick-connect relationship which is secure and leak-  
4       proof.

5           At the inward end of the nosecone extension  
6       42 as defined by the wall 143, a radially-inwardly  
7       projecting seal 147 is provided in the form of a bead  
8       or rim which is semi-circular in cross section as shown  
9       in detail in Fig. 13. The bead or rim 147 acts as a  
10      camming and locking member when the nosecone extension  
11      is inserted onto the nosecone 42 so that the bead 147  
12      rests in the recess 103 after camming along the surface  
13      104 of the nosecone 33, as shown in Fig. 6.

14       An irrigation cowl is generally depicted by  
15      the reference numeral 150 and defines an irrigation  
16      opening through an angled bore 151 therein terminating  
17      in an inlet irrigation port 152. The center line of  
18      the generally cylindrical irrigation bore 151, for the  
19      passage of irrigation fluid into the nosecone extension  
20      42, lies at an angle relative to the axis of the nose-  
21      cone extension 42 so that the bore 151 defines an  
22      elliptical opening 153 in the outwardly descending-  
23      diameter interior bore of the wall portion 142, as best  
24      seen in the side view of Fig. 15. The irrigation cowl  
25      150 includes a wall body portion 153 having an irreg-  
26      ular contour 154 as shown in Figs. 11, 13 and 14 to  
27      merge attractively with the nosecone extension 42.  
28       Such a nosecone extension 42 is convenient as providing  
29      a quick connection to the nosecone 33 itself at its  
30      inlet end by a mere snap fit coaction wherein the bead  
31      147 cams on the outward surface of the nosecone 33 and  
32      snap fits into the recess 103 of the nosecone 33 with a  
33      tactile indication which may also be heard by the  
34      assembler. In addition, such an arrangement permits  
35      rotation of the nosecone extension 42 about the nose-  
36      cone 33 to orient the irrigation cowl 150 and hence the

1 irrigation inlet opening 152 to a convenient circumfer-  
2 ential location for connection of the irrigation tube  
3 89 (see Fig. 5).

4 Similarly, the outlet end of the nosecone  
5 extension 42 provides a convenient quick connection for  
6 a flue 47, 49 which not only permits articulation of  
7 the flue to orient the outlet of the flue in a parti-  
8 cular direction relative to the axis of the nosecone,  
9 but also to center the flue around the tip therein,  
10 thus to accomodate tips of alternate shapes. The  
11 cooperating structure between the inlet of the flue and  
12 the outlet of the nosecone permits rotation of the flue  
13 thereabout and a tactile indication that the flue is  
14 properly seated upon the outlet of the nosecone exten-  
15 sion.

16 Figs. 16 and 17 illustrate a nosecone exten-  
17 sion adapter 57 for use with an extender sheath 60 when  
18 a curved elongated tip 54a and an associated extender  
19 56 are used, as shown in Fig. 3. With respect to the  
20 inlet end of the nosecone adapter 57, its components  
21 are similar to the inlet components of the nosecone  
22 extension 42 described in connection with Figs. 12-  
23 15. Thus, like reference numerals are utilized. Its  
24 outlet end differs, however, to provide a quick connec-  
25 tion to an extender sheath 60. Thus, the portion 140  
26 merges into a second cylindrical portion 170 defined in  
27 cross section by an annulus and extending outwardly  
28 from the wall portion 140 to define at its outermost  
29 surface an outwardly-flared portion 171, shown in  
30 detail in Fig. 17. The inside diameter of the out-  
31 wardly-flared portion 171 is defined by an outwardly  
32 tapering surface 172 while the outside diameter of the  
33 flared portion terminates in an apex 173 having a rela-  
34 tive maximum diameter. The structure thus permits an  
35 extender sheath 60 to be slip fit over the outward end  
36 of the nosecone extension adpater and secured therein

- 22 -

1       in a slip fit relation to an extent limited by the  
2       shoulder 170a. The apex 73 provides resistance to  
3       withdrawal of the extender sheath from the nosecone  
4       extension adapter 57 while the tapered portion 171  
5       permits a camming action of the extender sheath thereon  
6       during the insertion process to facilitate assembly.  
7       Otherwise, the elements of the nosecone extension adap-  
8       ter 57 are like those shown for the nosecone extension  
9       42 and cooperate in the same manner.

10       The articulating joint which was omitted from  
11       the nosecone extension adapter 57 is included on the  
12       outlet of the flue adapter 67 shown in Figs. 18-21.  
13       Thus, the flue extender adapter is structured to be  
14       inserted into an end of the extender sheath 60 opposite  
15       to that which receives the outlet end of the nosecone  
16       extension adapter. The articulating joint 70 of the  
17       flue adapter 67 is structured like the articulating  
18       joint on the nosecone extension 42 and thus need not be  
19       described in greater detail. The flue adapter 67 is  
20       defined by a body portion 180 having an inlet cylin-  
21       drical portion 181 defining at its inlet end 182 an  
22       apex 183 structured similarly to the outlet configura-  
23       tion of the nosecone extension 57. Thus, like refer-  
24       ence numerals are used.

25       The cylindrical portion 181 merges into a  
26       thickened outward wall portion 82 which tapers down-  
27       wardly toward the outlet end of the flue adapter 67 to  
28       define the articulating joint 70. At the area of  
29       merger between the thickened wall portion 182 and the  
30       cylindrical wall portion 181, a radially inwardly  
31       directed wall portion 184 is included, as best seen in  
32       cross section in Fig. 21. The interiorly-directed wall  
33       portion 184 thus defines a plurality of spaced semi-  
34       circular portions 185 equally spaced about the circum-  
35       ference of that wall portion to provide water passage  
36       through the structure. Preferably, the flue adapter is

- 23 -

1 made from a suitable medical grade plastic such as  
2 polycarbonate.

3 Returning to the embodiment of Figs. 2, 3,  
4 and 5, an irrigation fitting 78, shown in Figs. 22 and  
5 is utilized. The irrigation fitting 78 has an  
6 outlet end which is slip fit into the irrigation port  
7 on either the adapter or on the nosecone extension 42  
8 and has its inlet end suitably structured for receiving  
9 thin-walled tubing thereon. Fig. 22 thus shows a cross  
10 section of the irrigation fitting 78 having a tapered  
11 outlet wall portion 191, a central upwardly raised  
12 portion 192 terminating in an inlet wall portion 193  
13 having a radially outwardly extending barb 194 for  
14 securing the irrigation tubing 89 thereon. The taper  
15 of the outlet wall portion 191 facilitates its inser-  
16 tion into the irrigation port 79, while the barb 194  
17 resists withdrawal of the irrigation tubing 89 from the  
18 fitting 78. The central upraised wall portion 192  
19 provides a suitable bi-directional barrier against  
20 overinsertion of the irrigation fitting 78 into the  
21 irrigation port 79 and a suitable stop for the end of  
22 the irrigation tubing 89 when assembled as indicated  
23 diagrammatically in Fig. 4. In practice, the fitting  
24 has its outlet end 191 cold bent as seen in Fig. 23  
25 after turning to a suitable angle, such as about 24  
26 degrees, so that the fitting 190 can be inserted into  
27 the irrigation tube 89 and thus inserted into the irri-  
28 gation port having a correct angular orientation to  
29 direct the irrigation tube outwardly and parallel rela-  
30 tive to the body of the nosecone extension to the out-  
31 side of the aspiration tubulation connector, as well as  
32 parallel to the body of the handpiece 31. The irriga-  
33 tion tubing may also be secured by clips.

34 The aspiration tubulation connector 71 is  
35 shown in contour in Fig. 24 as defining an outward port  
36 75 for mating with the aspiration port 37 on the tip 34

- 24 -

1 and an inward port 202 for receiving an end of the  
2 aspiration tube 76 in a secure relationship. The  
3 aspiration tubulation connector 71 further includes a  
4 fluid passage between the inward port 202 and the out-  
5 ward port 75 through the exterior body portion 72, the  
6 fitting portion 73 and the transition portion 74. As  
7 can be seen from Figs. 3 and 4, when the aspiration  
8 tubulation connector 71 is snap fit into place within  
9 the nosecone extension, its snap fit portion 73 is  
10 rigidly secured within the slot 40, 41 defined in the  
11 nosecone 33. Similarly, its outwardly extending body  
12 portion 72 lies along the outside wall of the handpiece  
13 so that its inward port 202 is axially directed to  
14 accomodate the aspiration tube 76 along the exterior of  
15 the handpiece as shown in Fig. 4.

16 Preferably, the aspiration tubulation  
17 connector 71 is made of a left side component shown in  
18 Figs. 25A through 25F and a mating right side component  
19 as shown in Figs. 27A through 27F. The left side  
20 portion and the right side portion are thus joined  
21 together by mating male members 207 in the left side  
22 component with female openings 208 on the right side  
23 component. The inward portion 202 is tapered so that  
24 the aspiration tubing readily slides thereon to a  
25 shoulder 210 defined adjacent the portion 204. The  
26 interior passage between the inlet 202 and the outlet  
27 201 is designated generally by the reference numeral  
28 212 and is thus shown in either of Figs. 25 and 27.  
29 The inward port 202 defines an outwardly tapered inlet  
30 portion 212 in the outermost wall of the outlet portion  
31 213 to permit easy envelopment of the aspiration port  
32 on the tip. Preferably, the aspiration tubulation  
33 connector is made from a suitable medical grade  
34 material such as polycarbonate. The operation of the  
35 tubulation connector has been described in connection

- 25 -

1 with Figs. 3 and 4 and the connector is structured so  
2 as to permit ready and easy connection as described.

3 Fig. 28 shows a seal 300 in cross-section for  
4 providing a quick, positive, uncomplicated connection  
5 by a one-way valve (not shown) to a tissue release port  
6 on a console, as shown in Fig. 5. The outward end 302  
7 receives a vacuum tubing end in a slip fit relation-  
8 ship. The seal 300 includes a irregularly-shaped wall  
9 304 having a plurality of protrusion 306 for a slip fit  
10 connection to a T-valve assembly 308 shown in Fig. 5,  
11 by insertion of a tip 310 prior to the T-valve  
12 assembly. The protrusion 306 and in manipulating that  
13 insertion. The seal 300 thus provides an effective  
14 connector for tubing otherwise directly connected to  
15 the T-valve assembly 308.

16 The invention may be embodied in other speci-  
17 fic forms without departing from its spirit or  
18 essential characteristics. The present embodiments  
19 are, therefore, to be considered in all respects as  
20 illustrative and not restrictive, the scope of the  
21 invention being indicated by the claims rather than by  
22 the foregoing description and all changes which come  
23 within the meaning and range of the equivalents of the  
24 claims are therefore intended to be embraced therein.

- 26 -

WHAT IS CLAIMED IS:

1        1. In an ultrasonic surgical system of the  
2        type which comprises a handpiece which includes the  
3        combination of an ultrasonically vibrating tip, a nose-  
4        cone secured to a handle about said tip and means for  
5        vibrating said tip, the improvement comprising:

6                a nosecone extension means defining at one  
7        end thereof a rotating joint for connection to an out-  
8        ward side of said nosecone and at a spaced end thereof  
9        an articulating joint for connection to a flue envelop-  
10      ing said tip

11                a rotating joint as described in conjunction  
12      with resilient clips which provides an ergonomic and  
13      independent positioning of irrigation and aspiration  
14      ports on the surgical handpiece.

1        2. The combination as set forth in claim 1  
2        wherein said nosecone extension means includes a body  
3        defining at one end said articulating joint and at the  
4        other end said rotating joint, said body further  
5        defining an irrigation cowl having an irrigation port  
6        for receiving an irrigation fitting therein.

1        3. The combination as set forth in claim 1  
2        wherein said nosecone extension means includes a nose-  
3        cone extension adapter defining at one end said  
4        rotating joint and at its other end means for coopera-  
5        ting with an extender sheath, said nosecone extension  
6        means further including a flue adapter defining at its  
7        outer end said articulating joint and at its inner end  
8        means for cooperating with the other end of said  
9        extender sheath so that said nosecone extension  
10      adapter, said extender sheath, and said flue adapter  
11      are combined to envelop an extender and a portion of  
12      said tip, said nosecone extension adapter defining an  
13      irrigation cowl having an irrigation port for receiving  
14      an irrigation fitting thereon.

- 27 -

1           4. The combination as set forth in claim 2  
2        further including an irrigation tubing connector struc-  
3        turally adapted for insertion at one end into said  
4        irrigation port and at its other end for connection to  
5        said irrigation tubing.

1           5. The combination as set forth in claim 3  
2        further including an irrigation tubing connector struc-  
3        turally adapted for insertion at one end into said  
4        irrigation port and at its other end for connection to  
5        said irrigation tubing.

1           6. The combination as set forth in claim 4  
2        wherein said irrigation connector includes a tapered  
3        generally cylindrical portion for insertion in said  
4        irrigation port in said irrigation cowl of said nose-  
5        cone extension means, a shoulder portion limiting the  
6        insertion of said irrigation connector therein; and a  
7        barbed cylindrical portion for receiving an end of said  
8        irrigation tubing.

1           7. The combination as set forth in claim 5  
2        wherein said irrigation connector includes a tapered  
3        generally cylindrical portion for insertion in said  
4        irrigation port in said irrigation cowl of said nose-  
5        cone extension means, a shoulder portion limiting the  
6        insertion of said irrigation connector therein; and a  
7        barbed cylindrical portion for receiving an end of said  
8        irrigation tubing.

1           8. The combination as set forth in claim 1  
2        further including an aspiration tubulation connector  
3        defining an inlet port for connection with an aspira-  
4        tion port of said tip and an outlet port structurally  
5        adapted for connection to aspiration tubing.

1                   9. The combination as set forth in claim 8  
2       wherein said aspiration tubulation connector is further  
3       defined in that the axis of its outward port is axially  
4       offset from the axis of its inward port so that, when  
5       connected, said aspiration tubing lies along the out-  
6       side of the handle of said handpiece, said aspiration  
7       tubulation connector further defining a passage from  
8       said inward port to said outward port.

1                   10. The combination as set forth in claim 9  
2       wherein said aspiration tubulation connector includes a  
3       transition portion structurally adapted to frictionally  
4       engage a slot on said nosecone and said nosecone exten-  
5       sion means, when assembled, so that when said transi-  
6       tion portion is securely inserted in said slot, said  
7       outward port engages the aspiration port of said tip  
8       and said inward port lies along the outside of said  
9       handpiece.

1                   11. For use in an ultrasonic surgical aspir-  
2       ation system of the type which includes a handle  
3       assembly providing a source of ultrasonic vibrations to  
4       a tip, and a nosecone secured to said handle for envel-  
5       oping a connection between said tip and said vibration  
6       source, a nosecone extension comprising:

7                   a body comprising a first portion which  
8       includes means for cooperating with said nosecone to  
9       provide a rotating connection therewith and a bore  
10      therethrough for passage of said ultrasonically vibra-  
11      ting tip, said first portion merging into a second  
12      portion which is generally cylindrical and defining at  
13      its outer end an articulating joint structurally  
14      adapted for receiving a portion of a flue thereon in an  
15      articulating relationship.

- 29 -

1                   12. The nosecone extension as set forth in  
2        claim 11 further including an irrigation cowl defining  
3        an irrigation passage having an axis oblique to an axis  
4        of said nosecone extension, said irrigation cowl  
5        defining at its inward end an irrigation port struc-  
6        turally adapted for receiving a fitting connected to  
7        irrigation tubing.

1                   13. The nosecone extension as set forth in  
2        claim 12 wherein said first body portion defines an  
3        inwardly extending semi-circular bead which circumfer-  
4        entially extends about an inward end of said nosecone  
5        extension for engaging a mating recess on said nose-  
6        cone.

1                   14. The nosecone extension as set forth in  
2        claim 12 wherein said articulating joint is defined by  
3        an arcuate portion having a diameter the center of  
4        which lies on an axis of said nosecone extension and a  
5        recess in said arcuate portion for receiving an O-ring  
6        therein for articulatingly securing said flue thereon  
7        in a fluid-tight relationship.

1                   15. The nosecone extension as set forth in  
2        claim 14 in further combination with a flue having an  
3        elongated tapered body and defining a bore therein for  
4        passing said tip therethrough and defining at its  
5        inward end an arcuate portion having a contour which is  
6        structurally complementary with the contour of said  
7        articulating joint on said nosecone.

1                   16. The nosecone extension as set forth in  
2        claim 14 in further combination with a flexible flue  
3        having an elongated body portion terminating at its  
4        inward end in a radially extending flange for

- 30 -

5       connection with said articulating joint in a fluid-  
6       tight relationship.

1           17. The combination as set forth in claim 16  
2       wherein said flexible flue includes an elongated body  
3       defining a bore, said bore including at least one  
4       axially extending rib for strengthening said body.

1           18. The combination as set forth in claim 16  
2       wherein said flexible flue includes a plurality of  
3       axially extending ribs spaced about the circumference  
4       of the interior of said flexible flue.

1           19. The combination as set forth in claim 16  
2       wherein said flexible flue is made from a plastic  
3       material.

1           20. For use in an ultrasonic surgical system  
2       of the type which includes the combination of a sub-  
3       assembly of a handpiece, a nosecone, and a source of  
4       ultrasonic vibration for an extended tip, with an elon-  
5       gated extender enveloping a portion of said tip, the  
6       combination comprising:

7                a nosecone extension adapter defining at its  
8       inward end a rotating joint for connection with said  
9       nosecone on said sub-assembly and an axially extending  
10      circumferential portion for connection to an end of an  
11      extender sheath structurally contoured to envelope said  
12      extender and said tip, said nosecone extension adapter  
13      defining an irrigation port.

1           21. The combination as set forth in claim 20  
2       further including a flue adapter having an inward end  
3       structurally adapted to connect with the outward end of  
4       said extender sheath and defining at its outward end an  
5       articulating joint for connection to a flue.

1                   22. For use in connection with a nosecone  
2                   adapter in an ultrasonic surgical system of the type  
3                   which includes an irrigation cowl defining an irriga-  
4                   tion fluid passage in an assembled handpiece of an  
5                   ultrasonic surgical system, an irrigation tubing con-  
6                   nector which includes an elongated body, said elongated  
7                   body defining an outward end portion structurally adap-  
8                   ted for insertion in said irrigation port;

9                   a radially extending, centrally located rib  
10                  portion limiting the insertion of said first portion in  
11                  said irrigation port, and

12                  a second axially extending tubular port for  
13                  insertion in a tubing end of irrigation tubing, the  
14                  insertion of said second end being limited by said  
15                  centrally located rib.

1                   23. The irrigation tubing connector as set  
2                   forth in claim 22 wherein the end axis of said first  
3                   portion is oriented at an acute angle relative to the  
4                   axis of said second portion.

1                   24. The irrigation connector as set forth in  
2                   claim 23 wherein said angle is about 24°.

1                   25. The irrigation tubing connector as set  
2                   forth in claim 23 wherein said second portion includes  
3                   a circumferentially located barb tapered toward its  
4                   inward end to facilitate slip fitting of an end of said  
5                   irrigation tubing onto said irrigation connector and  
6                   inhibiting its withdrawal therefrom.

1                   26. For use in combination with an ultra-  
2                   sonic surgical aspiration system of the type which  
3                   includes a handpiece which includes a source of ultra-  
4                   sonic vibrations, a nosecone, and an ultrasonically  
5                   vibrating tip having a portion connected to said source

6       wherein said nosecone envelops at least a portion of  
7       said tip, the improvement comprising means for defining  
8       an irrigation manifold to provide a passage for irriga-  
9       tion fluid from a source to a surgical site adjacent  
10      the outward end of said surgical tip, said irrigation  
11      manifold means including a member rotatably connected  
12      to said nosecone and defining an irrigation passage  
13      oblique to an axis of said tip, said irrigation passage  
14      terminating in an irrigation port structurally adapted  
15      for connection to irrigation tubing to provide a source  
16      of irrigation fluid to the interior of said member,  
17      said member defining at its outward port means for  
18      quick connection to an end of a flue structurally  
19      adapted to envelop a portion of said tip, said flue and  
20      said member together defining an irrigation passage for  
21      flow of irrigation fluid from the interior of said  
22      member communicating with said source of irrigation  
23      fluid through said irrigation port and in the space  
24      defined by the outside of said tip and the interior of  
25      said flue.

1           27. In combination with an assembly of an  
2       ultrasonically vibrating tip having an aspiration port  
3       at an end thereof and communicating with an aspiration  
4       passage, said tip being connected to a source of ultra-  
5       sonic vibrations in a handpiece in an ultrasonic  
6       surgical aspiration system so that at least a portion  
7       of said tip being enveloped by a nosecone having a slot  
8       in register with a slot in said vibration source, said  
9       slots in register exposing said aspiration port of said  
10      tip when assembled to the exterior of said assembly,  
11      the improvement comprising an aspiration tubulation  
12      connector having an inlet port structurally adapted for  
13      connection to aspiration port on said tip, an outlet  
14      port structurally adapted for connection to aspiration  
15      tubing at the exterior of said nosecone, said aspira-

- 33 -

16      tion tubulation connector being structurally adapted to  
17      define an aspiration fluid passage through said slots  
18      in register from said inward port to said outward  
19      port.

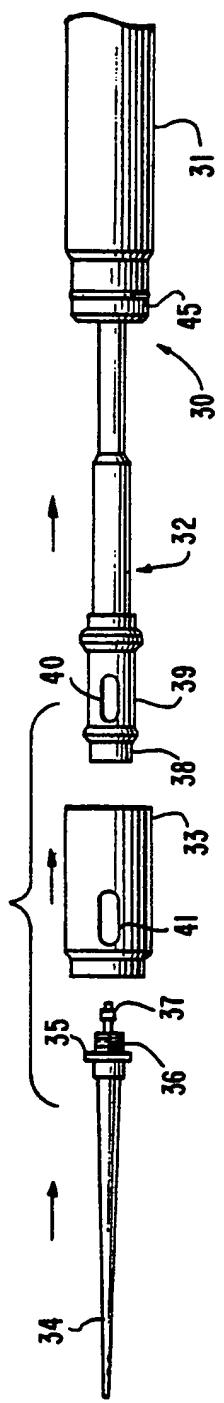
1                28. The aspiration tubulation connector as  
2      set forth in claim 27 further including a transition  
3      port structurally adapted to fit within said slot in a  
4      secure relationship when said outward fitting is  
5      secured to said aspiration port.

1                29. The aspiration tubulation connector as  
2      set forth in claim 28 further characterized in that  
3      said outlet port lie along an axis exterior to said  
4      handpiece, said axis being axially offset relative to  
5      the axis of said aspiration port on said tip and said  
6      inlet port on said connector.

1                30. The combination as set forth in claim 8  
2      further including a seal member for connection to a T-  
3      valve assembly in said aspiration tubing, said seal  
4      being structurally adapted for irrigation at one end  
5      into said T-valve assembly and at its other end for  
6      receiving tubing connected to a vacuum port on a  
7      console.

1                31. The combination as set forth in claim 27  
2      further including a seal member for connection to a T-  
3      valve assembly in said aspiration tubing, said seal  
4      being structurally adapted for irrigation at one end  
5      into said T-valve assembly and at its other end for  
6      receiving tubing connected to a vacuum port on a  
7      console.

*FIG. 1.*  
(PRIOR ART)



*FIG. 2.*

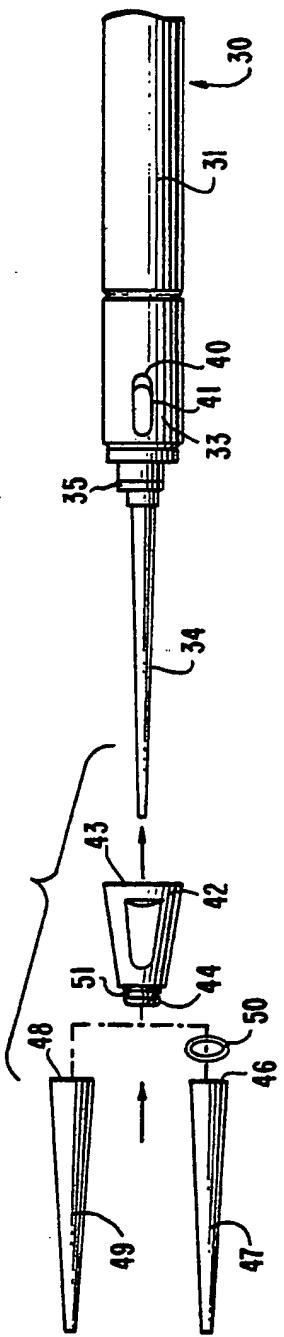


FIG. 3.

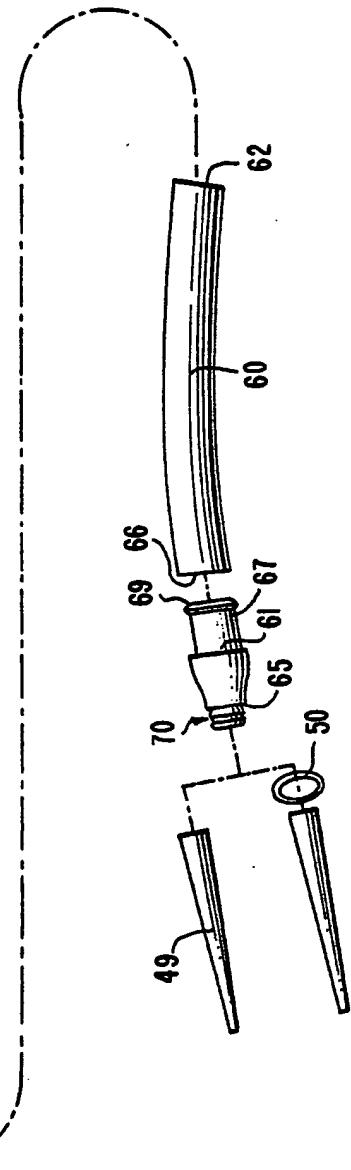
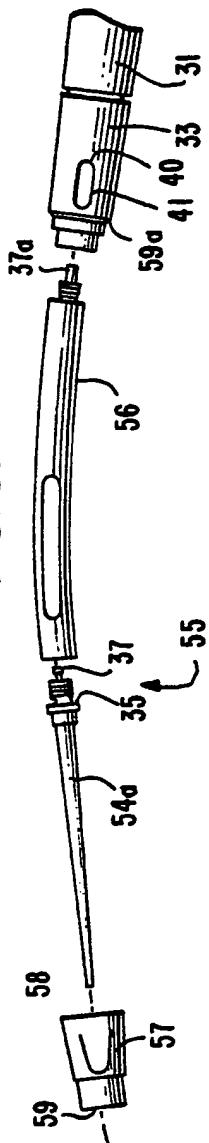


FIG. 4B.

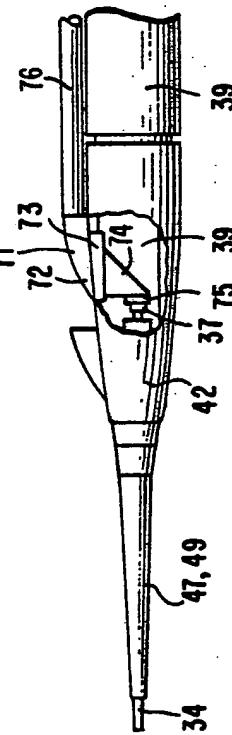
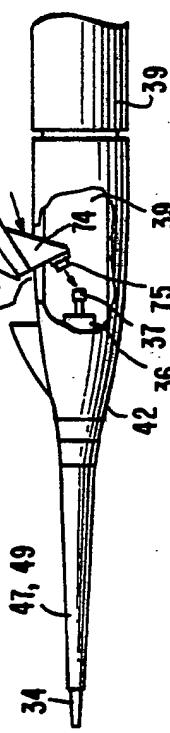


FIG. 4A.



3/9

TO TISSUE RELEASE PORT

94  
308  
"T" VALVE ASSEMBLY  
TO PINCH  
VALVE AND  
VACUUM  
CANISTER

FIG. 5.

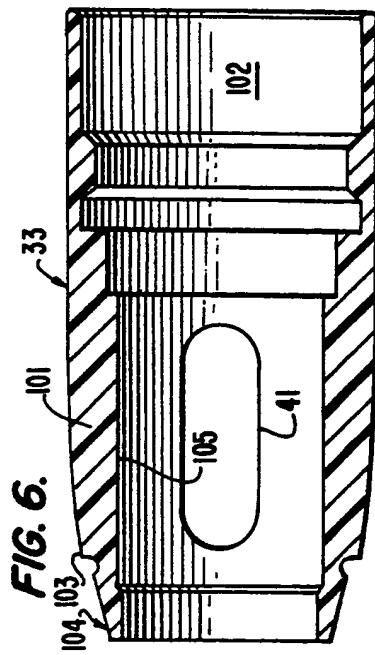


FIG. 6.

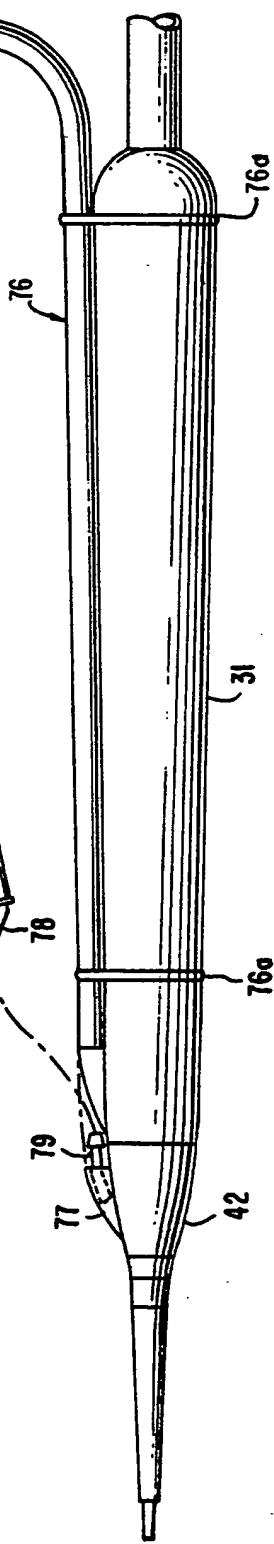
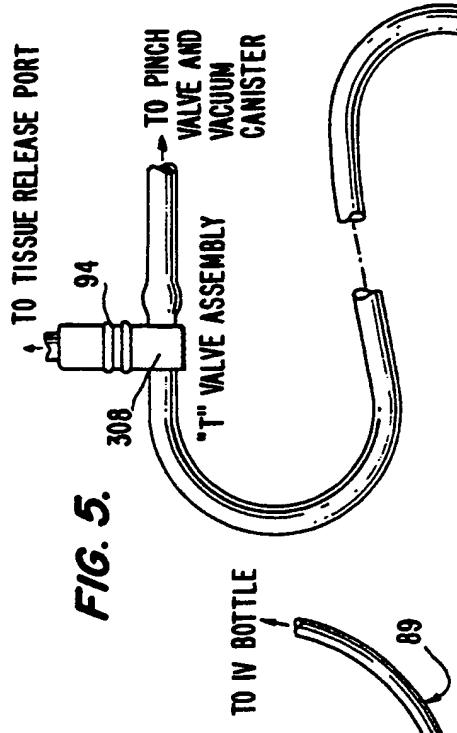
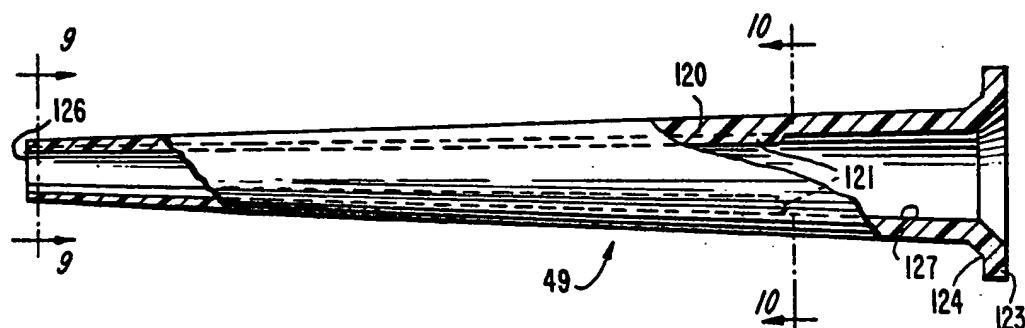
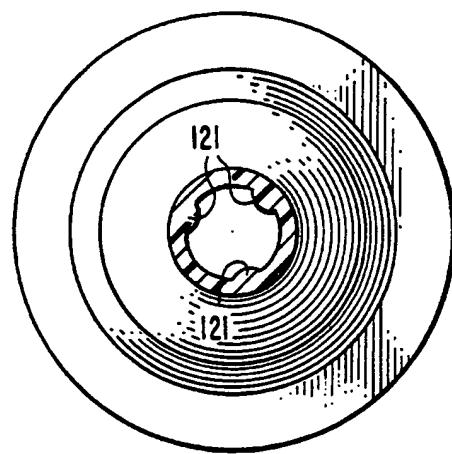


FIG. 7.

4/9

**FIG. 8.****FIG. 9.****FIG. 10.**

5/9

FIG. 11.

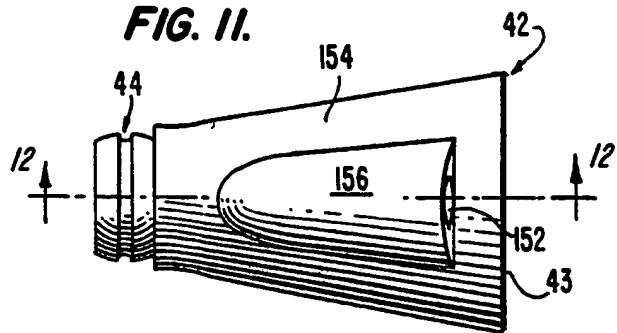


FIG. 12.

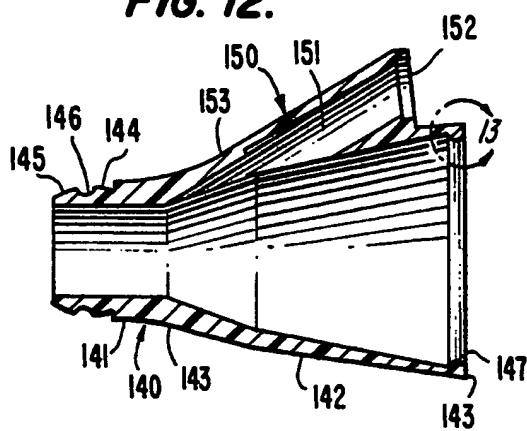
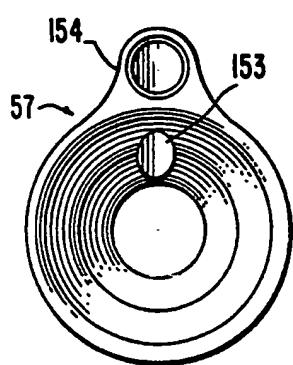
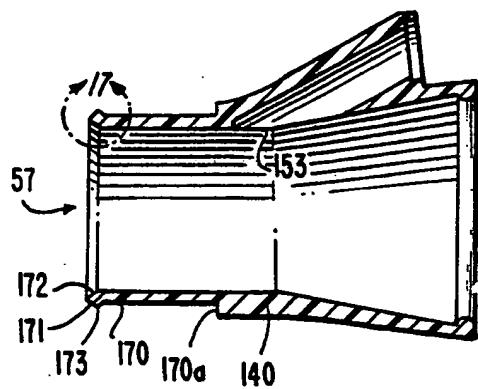
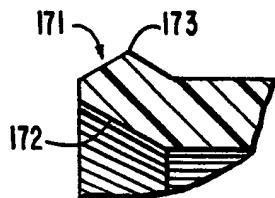
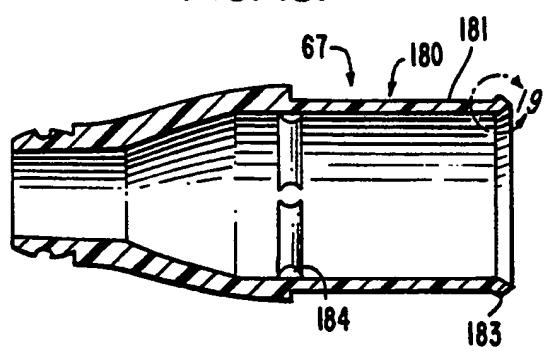
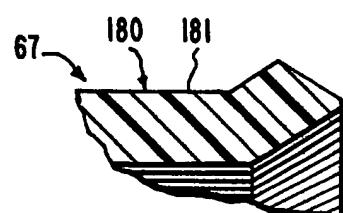


FIG. 14.

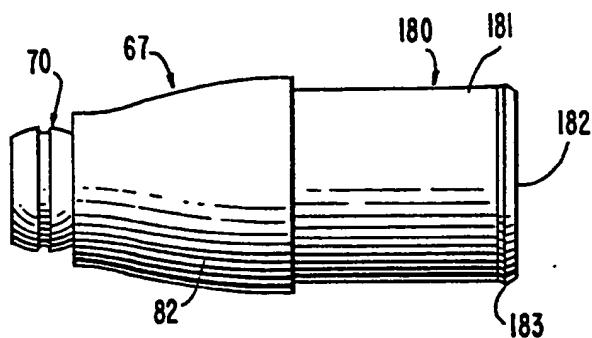
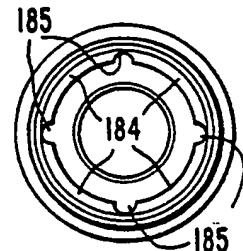
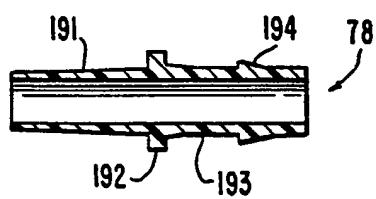
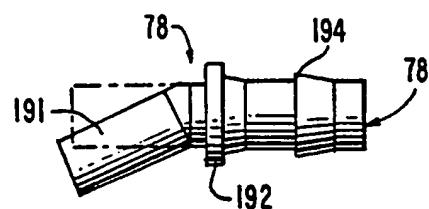
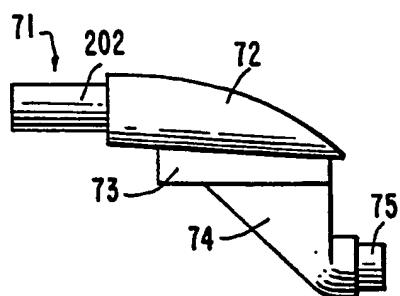
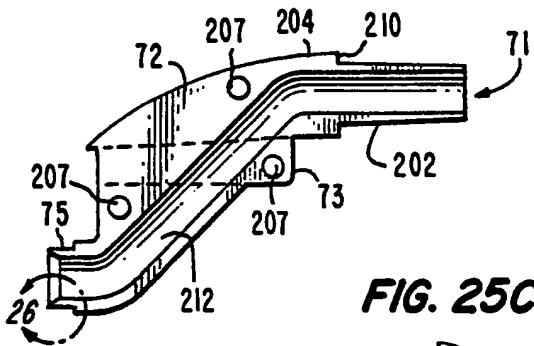
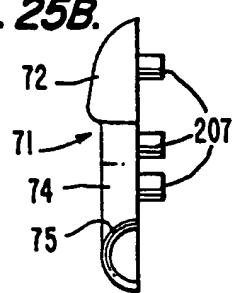
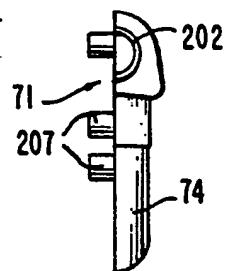
FIG. 13.



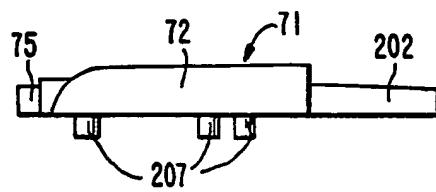
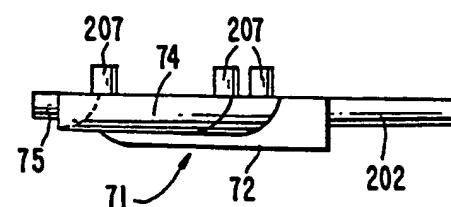
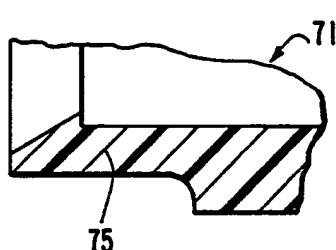
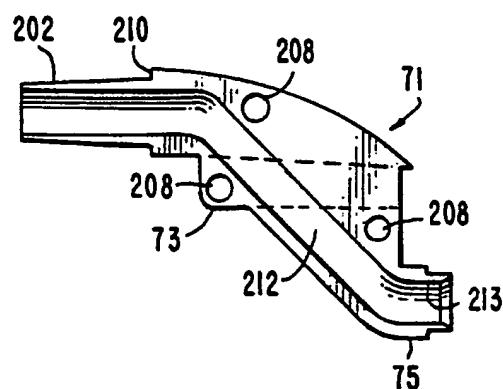
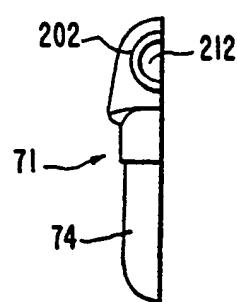
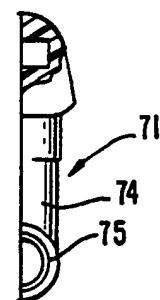
6 / 9

**FIG. 15.****FIG. 16.****FIG. 17.****FIG. 18.****FIG. 19.**

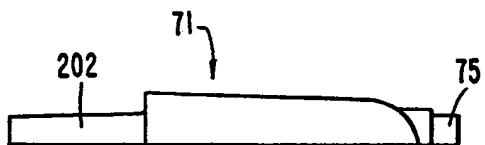
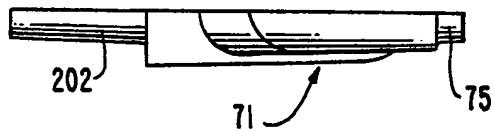
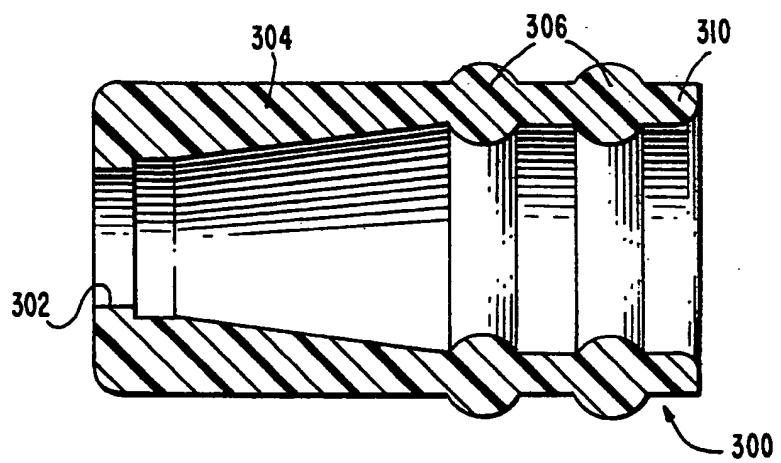
7/9

**FIG. 20.****FIG. 21.****FIG. 22.****FIG. 23.****FIG. 24.****FIG. 25A.****FIG. 25B.****FIG. 25C.**

8/9

**FIG. 25D.****FIG. 25E.****FIG. 26.****FIG. 27A.****FIG. 27B.****FIG. 27C.**

9/9

**FIG. 27D.****FIG. 27E.****FIG. 28.**

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US87/00795

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) \*

According to International Patent Classification (IPC) or to both National Classification and IPC  
**IPC (4): A61B 17/00**  
**U.S. Cl. 604/22, 35, 43, 283; 128/24A**

## II. FIELDS SEARCHED

Minimum Documentation Searched \*

Classification System	Classification Symbols
U.S.	604/22, 35, 39, 40, 43, 198, 283; 188/24A, 303
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched *	

## III. DOCUMENTS CONSIDERED TO BE RELEVANT \*\*

Category *	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
X	US, A, 4,063,557 (WUCHINICH ET AL) 20 December 1977, see the entire document.	20 27
A	US, A, 3,589,363 (BANKO) 29 June 1971 See the entire document.	
A	US, A, 4,223,676 (WUCHINICH ET AL) 23 September 1980, see the entire document.	
A	US, A, 4,246,902 (MARTINEZ) 27 January 1981 See the entire document.	
A	US, A, 4,508,532 (DREWS ET AL) 02 April 1985, see the entire document.	

\* Special categories of cited documents: <sup>15</sup>

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"Z" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search \*

01 June 1987

Date of Mailing of this International Search Report \*

29 JUN 1987

International Searching Authority \*

ISA/US

Signature of Authorized Officer \*\*

S.C. Pellegrino

